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DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION SPECIFICATION

CABLE, ELECTRICAL CONTROL, EXTERIOR

1. SCOPE.

1.1 Scope. - This specification covers the requirements for various types of exterior multi-conductor cables, paired and unpaired, individually shielded or overall shielded that are used for control. They will have either polyvinyl chloride, polyethylene or ethylene propylene rubber insulation, a moisture resistant compound filled core and an overall shield or armor, if specified, and a polyethylene or polyvinyl chloride jacket.

1.2 Classification. - Four types of cable are covered by this specification:

Type 1A - AWG 18 or 22 twisted shielded pair conductors with polyvinyl chloride, polyethylene or ethylene propylene rubber insulation rated at 300 volts, each pair individually shielded having an overall jacket suitable for duct or overhead installation.

Type 1B - AWG 18 or 22 twisted shielded pair conductors with polyvinyl chloride, polyethylene or ethylene propylene rubber insulation rated at 300 volts, each pair individually shielded and having an armor and outer jacket suitable for DEB direct earth burial.

Type 2A - AWG 18 through AWG 8 unpaired conductors, with polyvinyl chloride, polyethylene or ethylene propylene rubber insulation rated at 600 volts, having an overall shield, and an outer jacket suitable for duct or overhead installation.

Type 2B - AWG 18 through AWG 8 unpaired conductors, with polyvinyl chloride, polyethylene or ethylene propylene rubber insulation rated at 600 volts, with an overall shield, an armor, and an outer jacket suitable for direct earth burial DEB.

2. APPLICABLE DOCUMENTS and INDUSTRIAL STANDARDS. - The following documents form a part of this specification, and are applicable to the extent specified herein.

2.1 International Organization for Standardization (ISO).

ISO 9003 Model for Quality Assurance in Final Inspection and Test.

ISO 10012-1 Quality Assurance Requirements for Measuring Equipment.

2.2 Industry standards.

2.2.1 American Society for Testing and Materials Specifications ASTM.

ASTM D 4566-94 Standard Test Methods for Electrical Performance

2.2.2 Insulated Cable Engineers Association Specification ICEA.

ICEA S-84-608 Telecommunications Cable Filled, Polyolefin Insulated, Copper Conductor

ICEA S-73-532 Standard for Control Cables.

ICEA-T-27-581 Standard Test Methods for Extruded Dielectric Power, Control, Instrumentation and Portable cables.
Also called NEMA WC 53-1983

2.2.3 Rural Electrical Administration REA.

REA BULLETIN REA Specification for Filled Telephone Cables.

PE-39 6/93 1753-205

2.2.4 National Electrical Manufacturers Association Specification NEMA.

WC-26-94 Wire and Cable Packaging Standard

2.3 Precedence of documents. - In the event of a conflict between the above-mentioned documents and this specification, this specification shall govern. Copies of the above documents may be obtained as follows:

2.4 Document sources.
Copies of this specification may be obtained from the Federal Aviation Administration office issuing the invitation for bids, Attention: Contracting Officer. Requests should fully identify material desired, i.e., specification number, date, amendment number; also, requests should state the contract involved, or other use to be made of the requested material.

ASTM Specifications may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ICEA Specifications may be obtained from the Insulated Cable Engineers Association, P.O. Box P, South Yarmouth, MA 02664.

NEMA Specifications may be obtained from the National Electrical Manufacturers Association, 2101 L Street, NW, Washington, D.C. 20037.

ISO standards may be obtained from the American National Standards Institute, ANSI, 11 West 42 Street, 13th floor, New York, 10036 NY.

REA specifications may be obtained from the US Department of Agriculture (USDA), Rural Electrification Administration (REA), Washington, and DC 20250-1500.
Publication Office, PDMB, Room 0174-S, AG Box 1533.

3. REQUIREMENTS.

3.1 Materials. - Materials shall be as specified herein. The insulation and jacket materials shall be made from virgin compounds.

3.2 Workmanship. - Cable shall be manufactured and processed consistent with the requirements defined in ICEA S-73-532. The cable shall be free of any imperfections that may affect its serviceability.

3.3 Design and construction. - The finished cable shall be circular in cross section except where noted otherwise herein.

3.3.1 Conductors. - Each conductor in the cable shall consist of stranded wire, in accordance with ICEA-S-73-532, paragraph 2.3.3

3.3.1.1 Materials. - The conductors shall be soft drawn or annealed copper in accordance with ICEA-S-73-532, paragraph 2.3.1.1.

3.3.1.2 Conductor joints. - Joints made in conductors during the manufacturing process shall have been welded, or brazed using a silver alloy and non-acid flux. Conductor joints shall be free from lumps and sharp protrusions. The tensile strength of any section of a conductor having a factory joint shall be not less than 85 percent of the tensile strength of any section of the conductor without a joint.

3.3.2 Mutual capacitance. - In types 1A and 1B the mutual capacitance shall not exceed 35 pf/ft.

3.3.3 Insulation materials. - Conductor insulation materials shall be polyvinyl chloride (PVC), ethylene propylene rubber (EPR) or polyethylene. A four-mil layer of nylon may be substituted for four mils of the specified thickness of PVC specified in paragraph 3.3.3.1.

3.3.3.1 Insulation thickness. - Insulation thickness shall be in accordance with ICEA S-73-532 Table 3-1.

3.3.3.2 Repairs. - Repairs to the insulation are permitted in accordance with the stipulations in ICEA S-73-532 paragraph 3.3.11 using heat fusing and insulation grade compound or suitable heat shrinkable sleeves.

3.3.4 Conductor identification.

3.3.4.1Types 1A and 1B. - Conductor identification shall be as stipulated in ICEA S-73-532, Appendix E paragraph E.3.1 (Method 1referencing Table E-2) and paragraph E.3.7 (Method 7 referencing Table E-2).

3.3.4.2Types 2A and 2B. - Conductor identification shall be as stipulated in ICEA S-73-532, Appendix E paragraph E.3.1 (Method 1referencing Table E-2).

3.3.5 Cabling of core.

3.3.5.1 Forming of pairs. - Type 1A and 1B insulated conductors shall be twisted into pairs in a manner which minimizes the susceptibility to cross talk.

3.3.5.2 Forming of cable. - Cables consisting of two or more twisted pairs or four or more unpaired conductors shall be cabled together with either a right or left hand lay, and where necessary the interstices shall be filled to give the cable a circular cross section. Flame retardant non-wicking and non-hygroscopic fillers may be used to provide a round cable.

3.3.6 Filler compound. - For type 1B and 2B the cable core shall be filled with a moisture resistant compound which is neither a dermal irritant nor toxic. For terminating or splicing purposes, the compound shall be removable by merely wiping with a dry cloth. The filler shall completely fill the core. If colored, the coloring of the compound shall not interfere with conductor identification. The compound shall be compatible with the conductor insulation, core covering, shield/armor and jacket. The compound melting characteristics shall meet the requirements of paragraph 4.3.5.

3.3.7 Shielding.

3.3.7.1 Shield. - All types shall have either individually shielded pairs or an overall shield consisting of 100 % coverage with aluminum polyester foil shield. Type 1A and 1B shield shall consist of a two-layer tape consisting of a polyester base bonded to aluminum foil. Type 2A and 2B shall be as stipulated in ICEA S 73-532 paragraph 4.1 through 4.1.3.

3.3.7.2 Drain wire. - For all types, an uninsulated, tinned, copper drain wire shall be included and shall be in continuous contact with the shield. The drain wires shall be as stipulated in ICEA S 73-532 paragraph 4.1.3.1.

3.3.7.3 Shield tape application and drain wire. - The tape shield shall be applied such that the aluminum foil is in continuous electrical contact with the drain wire. For types 1A & 1B cable the shield tape shall be constructed and applied such that contact of the conductive side of the foil of adjacent pairs does not occur. The shield coverage of the conductors shall be as stipulated in ICEA S 73-532 paragraph 4.1.3.

3.3.8 Armor.

3.3.8.1 General. - Type 1B, and 2B, cables shall have either an armor or a tape applied over the core covering as stipulated in ICEA S 73-532 paragraph 4.3.5 and 4.3.6 before the application of the outer jacket.

3.3.8.2 Armor/cladding. - Type 1B shall have aluminum continuous lightweight exterior (C-L-X) armor construction or better. For type 2B copper clad stainless steel armor shall be as stipulated in ICEA S73-532 paragraph 4.3.6.

3.3.9 Jacket.

3.3.9.1 General. - A jacket shall be applied over the shield or armor in accordance with ICEA S 73-532 paragraph 4.3.7. It shall be free of irregularities as stipulated in ICEA S73-532 paragraph 4.3.7.2.

3.3.9.2 Material. - Type 1A and 1B shall have a jacket of black sunlight resistant PVC. Type 2A and 2B shall have a jacket as stipulated in ICEA S-73-532, paragraph 4.2.

3.3.9.3 Integrity. - Opening of the cable jacket during manufacturing for repair or for any other purpose will not be permitted. Minor jacket defects not in excess of 0.125 inch size in any direction may be repaired by using heat fusing and jacket grade compound.

3.3.9.4 Thickness. - Jacket thickness for types 1A and 1B shall be in the range of 50 mils for (4) pairs to 70 mils for (24) pair cable. For type 2A it shall be as stipulated in ICEA S-73-532 paragraph 4.2.1 and table 4.1. Type 2B shall be as stipulated in paragraph 4.3.7.1 and table 4-11.

3.3.10 Special construction. - Cables containing two shielded groups may have flat oval construction if necessary for manufacturing reasons.

3.4 Cable identification. All cables shall be provided with markings as stipulated in ICEA S-73-532 section 5.4 and Appendix E.

4. QUALITY ASSURANCE PROVISIONS.

4.1 Quality control program. -The contractor shall maintain a quality control program in accordance with ISO 9003 and ISO 10012-1. The contractor shall have a copy of a current qualification test report for a cable of equal or similar construction showing compliance with this specification. The FAA shall have the option to have these tests witnessed by a government representative. The contractor shall furnish certified test reports and the manufacturer's current Qualification Test Report (QTR). Any reel of cable offered for inspection but failing to meet the requirements of the tests for the inspection may not be offered for a retest without the approval of the Contracting Officer.

4.2 Tests to be performed on all completed cables. - All cables to be manufactured in response to an IFB shall be tested at the factory for the parameters specified in the ensuing paragraphs and certified test results shall be submitted to the Government.

4.2.1 Conductor faults. - Each length of cable shall be free of grounds, open circuits, crosses or short circuits.

4.2.1.1 Conductor resistance. - Conductor resistance measurement shall comply with the method described in sections 6.2 of ICEA S-73-532 and 1.1 of ICEA T-27-581.

4.2.2 Mutual capacitance. - Mutual capacitance shall be measured in accordance with ASTM D-4566 section 18.

4.2.3 Voltage withstand test. - In each length of cable the insulation between conductors shall undergo a voltage withstand test as specified in ICEA T-27-581 paragraph 1.2.

4.2.4 Shield test. - The shield and drain wire on each shielded pair for types 1A & 1B as well as the overall shield for types 2A & 2B on each length of cable shall be tested for continuity. Using a foot sample from each reel, no exposure of the conductors shall occur when coiled three times around a mandrel sized a maximum of ten times the diameter of either the pair for type 1A or the cable for type 1B.

4.2.5 Conductor identification. - Verify that conductor identification is in accordance with paragraph 3.3.4 of this specification.

4.2.6 Jacket integrity. - The cable shall be spark tested as per section 6 of ASTM D-4566. The acceptable default rate is to be determined by section 7 of ASTM D4566. All repairable faults (see paragraph 3.3.3.2) shall be tested after repair.

4.3 Qualification tests. - The contractor shall provide, when stipulated by the Government, certified summary records of qualification test results for all cable attributes cited in section 3, or if stipulated in the invitation for bids (IFB) referee samples per the following.

4.3.1 Referee samples. - Samples shall be prepared in accordance with sampling methods and practices cited in REA PE-39, Appendix A, paragraph 2, Qualifications Test Methods Bulletin.

4.3.2 Shipment of samples. - Where the shipment of samples for referee tests is required, such shipment will be at Government expense on a Government bill of lading. Packing of samples and delivery to common carrier shall be at the expense of the contractor.

5. PREPARATION FOR DELIVERY.

5.1 General. - Unless otherwise indicated, each reel shall contain one continuous length of cable within a tolerance of plus 5 minus zero percent per reel.

5.2 Cable reels.

5.2.1 Cable reel construction. - Cable reels shall be new and nonreturnable, and shall comply with the requirements of NEMA WC-26, Wire and Cable Packaging, Table I for wood. The drum diameter shall be a minimum of 24 inches. Plywood reels are not acceptable.

5.2.2 Cable protection. - The reels shall be designed for storage outside in unprotected areas, and shall include provisions for rainwater/moisture drainage when the reels are stored both on end and on side. A layer of reflective material such as white water-resistant paper, white plastic, or aluminum foil shall be placed completely over the outer layer of cable on the reel.

5.2.3 Cable reeling. - The capacity of reels shall be sufficient to allow a spacing of a minimum of two cable diameters between the top layer and the lagging specified in paragraph 5.2.5 of this specification. The cable shall be secured so as to prevent being displaced during shipment.

5.2.4 Oversized reels. - Where the size of the reels required exceeds the maximum size listed in NEMA WC-26, reels shall be constructed consistent with the intent and the requirements of NEMA WC-26. The ends of cable shall be sealed to exclude moisture. Flange cable entry slot and cable ends shall be covered with a minimum of 18-gauge metal plate. Where the gross weight exceeds 2500 pounds, metal reel centers shall be provided.

5.2.5 Reel lagging and strapping. - Reels shall be lagged with nominal two-inch by four-inch # 2 common lumber. Lagging shall be edge to edge around the reel circumference and shall be strapped with two or more steel straps over the lagging.

5.3 Reel marking. - The reel shall be marked with the following information, permanently applied on the flange with ink or paint:

(a) "manufactured in accordance with FAA-E-2042c Type ___".

(b) conductor size, type and number (specify pairs).

(c) year of manufacture.

(d) length of cable, number of pairs.

(e) contractor's name.

(f) contract number under which cable was purchased.

(g) NSN, national stock number (if provided).

(h) name and address of consignee.

6. NOTES. - The subparagraphs below are only for the information of the Contracting Officer (CO). They are intended to assist the CO in formulating a contract. They are not contract requirements, nor binding on either the Government or the contractor, except to the extent that they may be specified elsewhere in the contract as such. The contractor shall not rely on the information in these subparagraphs.

6.1 Items requiring specification in the Invitation for Bids (IFB).

6.1.1 Number and size of conductors. - The IFB must indicate the number of conductors and the size of conductors.

6.1.2 Cable length per reel. - The IFB must include the cable length per reel. The suggested wording for variance in quantity is the following:

> "Cable shall be supplied on nonreturnable reels in continuous lengths of (See paragraph 5.1) XXXX feet plus 5 minus zero percent per reel containing no splices"

6.1.3 Cable pairs. - Procurement provisions should include the number of pairs required per cable.

6.2 Testing.

6.2.1 Factory inspection option. - The IFB shall state that the Government shall have the option of witnessing production tests conducted at the factory (See paragraph 4.1). Regardless of whether the government witnesses the production tests, the contractor shall furnish certified test reports and the manufacturers most recent Qualification Test Report as specified in 4.1.

6.2.2 Referee samples. - The IFB must indicate if and subject to what conditions, referee samples for independent qualification testing will be required.

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